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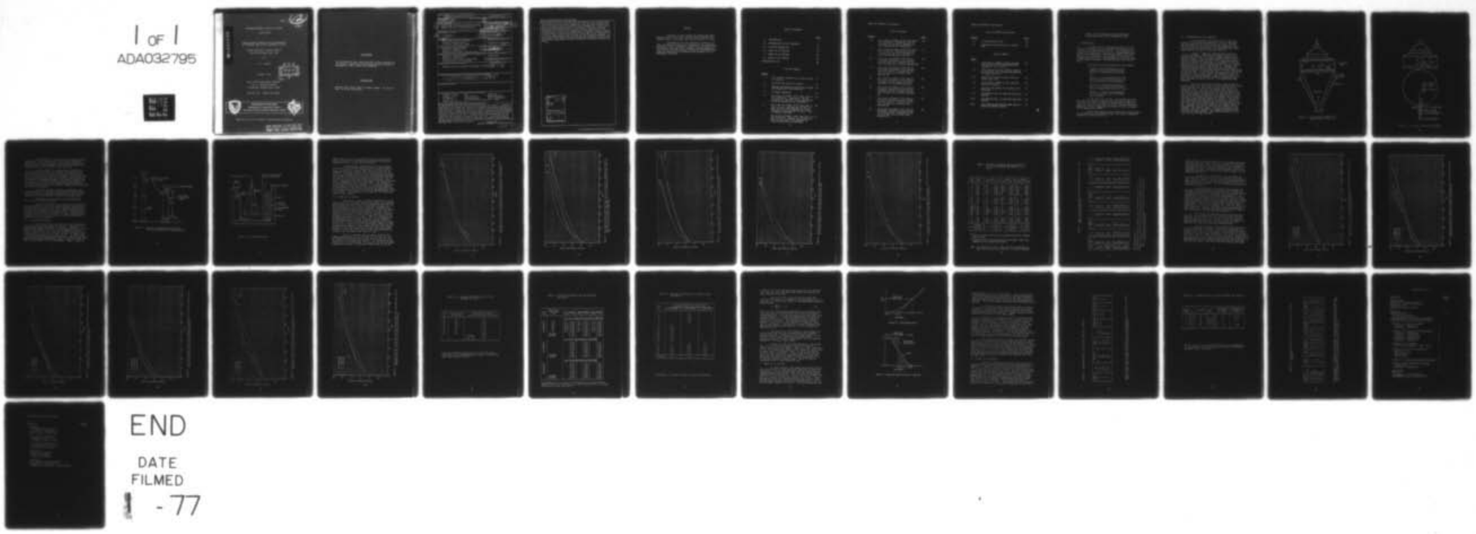

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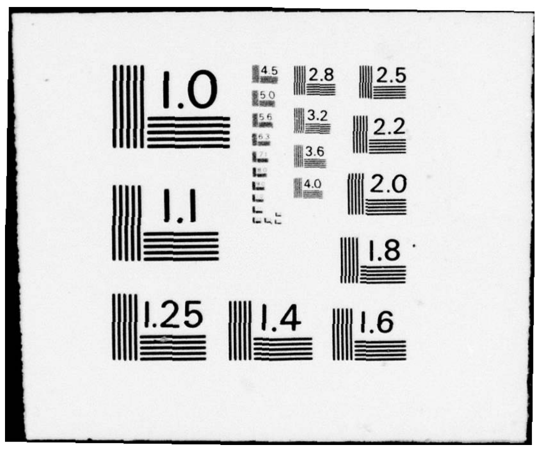
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EDGEWOOD ARSENAL CONTRACTOR REPORT

ED-CR-76101

PROBE-IN-BED TECHNIQUE FOR DETERMINATION OF RESIDUAL GAS LIFE OF CHARCOAL FILTERS

Second Quarterly Progress Report
May 1976 through July 1976

by

A.J. Juhola

October 1976

MINE SAFETY APPLIANCES COMPANY
201 N. Braddock Avenue
Pittsburgh, Pennsylvania 15208

Contract No. DAAA15-76-C-0067

U.S. ARMY ARMAMENT COMMAND

DEPARTMENT OF THE ARMY
Headquarters, Edgewood Arsenal
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Charcoal filters	DMMP	Whetlerite
Residual gas life	Agent exposures	Xylene adsorption
M11 canister	Moisture exposure	Filter contamination
Residual GB life	Accelerated filter aging	Charcoal bed
Probe-in-bed technique	CK	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Probe-in-bed testing with CK was completed for phases IA, IB and II. Because the adsorption front extends over the total M11 test-bed length, probes representing 25%, 50% and 75% of total gas life are all within 0.9 cm or 33% from the effluent end of the bed. Distances of 0.05 cm are critical and because the probe diameter is 0.12 cm and whetlerite granule diameter range is from 0.06 to 0.17 cm, correct location of probe is difficult. The probes always measure percentages of the total gas life regardless of length of total gas life. This was true also of phase II tests on whetlerites that had been aged or exposed to sulfur dioxide,

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formaldehyde or xylene vapors and where the total gas lives were very short. Some of the better test results showed that it was possible to measure the gas life at the 75% probe within ±6% of the calculated life. Phase IB tests involving intermittent flow of CK-air and pure air through the canister, showed that no CK drifted from one probe to the next with pure air flow. CK concentration at a probe, after breakthrough at 0.008 mg/l occurred, dropped to zero in about 3 minutes with pure air flow and when CK was introduced into the gas stream recovery time to 0.008 mg/l was also about 3 minutes. This means that in field test units, the test gas must be metered into the filter for several minutes before a reliable indication is obtained on residual gas life.

PREFACE

The work in this report was authorized under Contract DAAA15-76-C-0067, Probe-in-Bed Technique for Determination of Residual Gas Life of Charcoal Filters.

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PROBE-IN-BED TECHNIQUE FOR DETERMINATION OF RESIDUAL GAS LIFE OF CHARCOAL FILTERS

I. INTRODUCTION

The objective of the subject study is to develop a field test unit to determine the residual gas life of an exposed charcoal filter. The technique involves the insertion of a probe at a predetermined bed depth in the charcoal filter through which a sample of test gas is drawn while a short burst of test gas is passed into the filter. Non-appearance of the test gas at the probe indicates a minimum gas life for the filter.

The study is being performed in four phases:

Phase I. An investigation of the technique under standardized conditions to determine its workability.

Phase II. An investigation of the effect of environmental variables on the reliability of the technique.

Phase III. Check out of probe as means for measuring minimum protective requirement of a gas filter.

Phase IV. Design and development of the field test unit utilizing the technique.

During the first quarter, the preparatory work was done in regard to construction of probe-in-bed testing line and lines for aging of whetlerite and their exposure to low concentrations of sulfur dioxide, formaldehyde and xylene. These were described in the First Quarterly Report ED-CR-76087.

During the second quarter additional construction of equipment was completed and test runs made to complete phases IA, IB and II for CK.

II. PREPARATION OF TEST CANISTER

The uniformity with which the M11 test canister can be loaded with whetlerite is very important to the success of the study since the probes for the 25%, 50% and 75% of total gas life are located within 0.9 cm of the effluent end of the whetlerite bed. Bed depth should not vary by more than 0.05 cm.

Figure 1 shows the construction of the M11 canister assembly. Whetlerite bed depth comes to 2.8 cm when the assembly is tightly clamped together with three C-clamps. The calculated volume at 10.5 cm dia and 2.8 cm depth comes to 243 cc but attempted loadings at 240 cc required a great deal of pressure to get the depth to 2.8 cm. An M11 production canister was emptied and the measured volume came to 245 cc. However, the retainers on each end of the bed bulged considerably. It was advisable to stay below 240 cc to avoid distortion of the retainer. Up to Run 32, 220 cc (131 g) whetlerite were used. Only a small amount of compression was required to close the assembly. Some of the CK gas lives were low, so the whetlerite volume on subsequent runs was increased to 230 cc (137 g). No loading problems appeared.

Figure 2 shows the location of the probes at 0.5 cm spacing for the initial runs to determine the ultimate locations for the probes at 25%, 50% and 75% of total gas life. Initially the probes were used as received, but when they were inserted into the whetlerite bed they plugged up immediately. To correct this a 140 U.S. sieve screen was cemented with epoxy onto the bevel opening of the needle and also the needles were placed into the septums before whetlerite laoding. The end of the needle was then adjusted as closely as possible to the exact desired distance from the influent end of the bed. Because of the resilience of the rubber septum it was suspected that during loading and clamping of the assembly the needles moved. To avoid movement of the needles, the space between the septum and canister was filled with epoxy cement. Each needle extends 2 cm toward the axis of the canister.

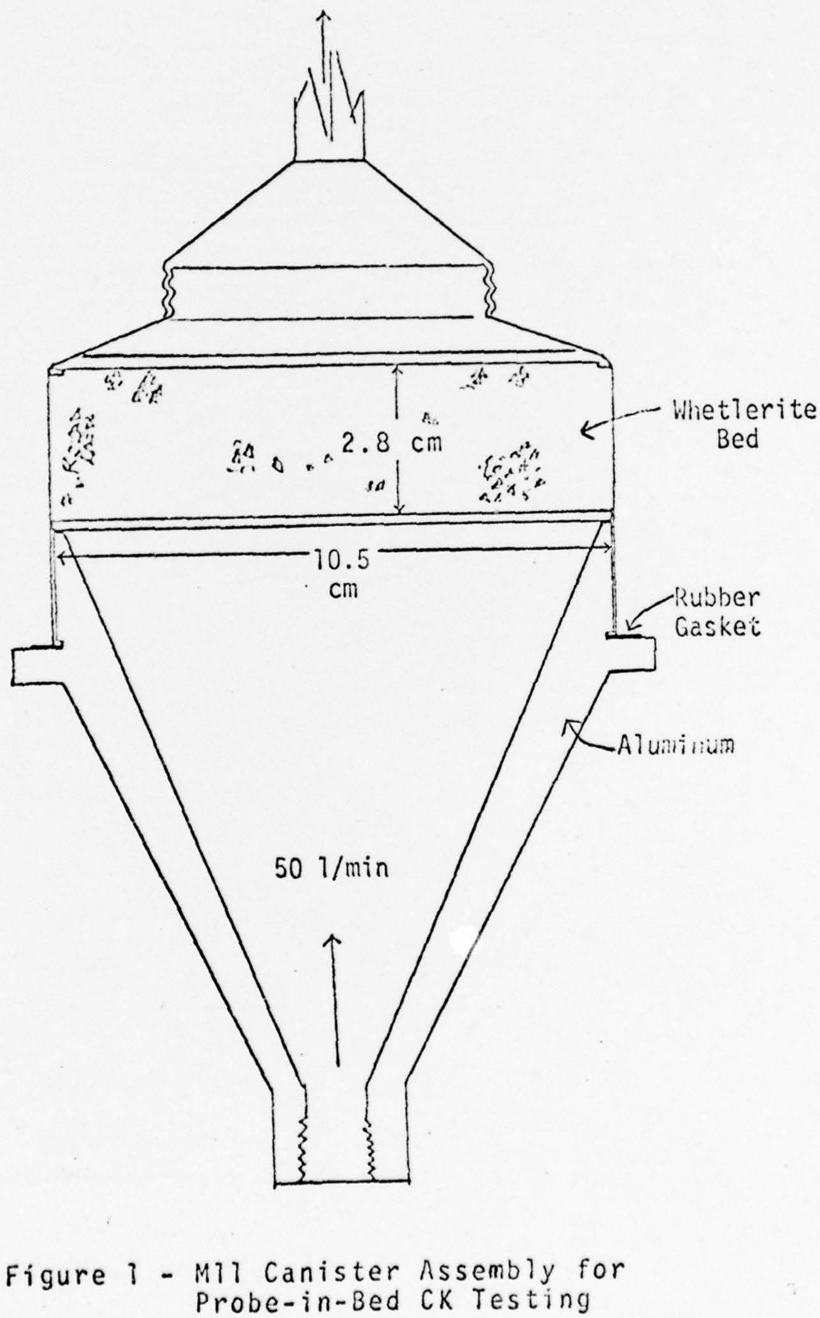

Figure 1 - M11 Canister Assembly for Probe-in-Bed CK Testing

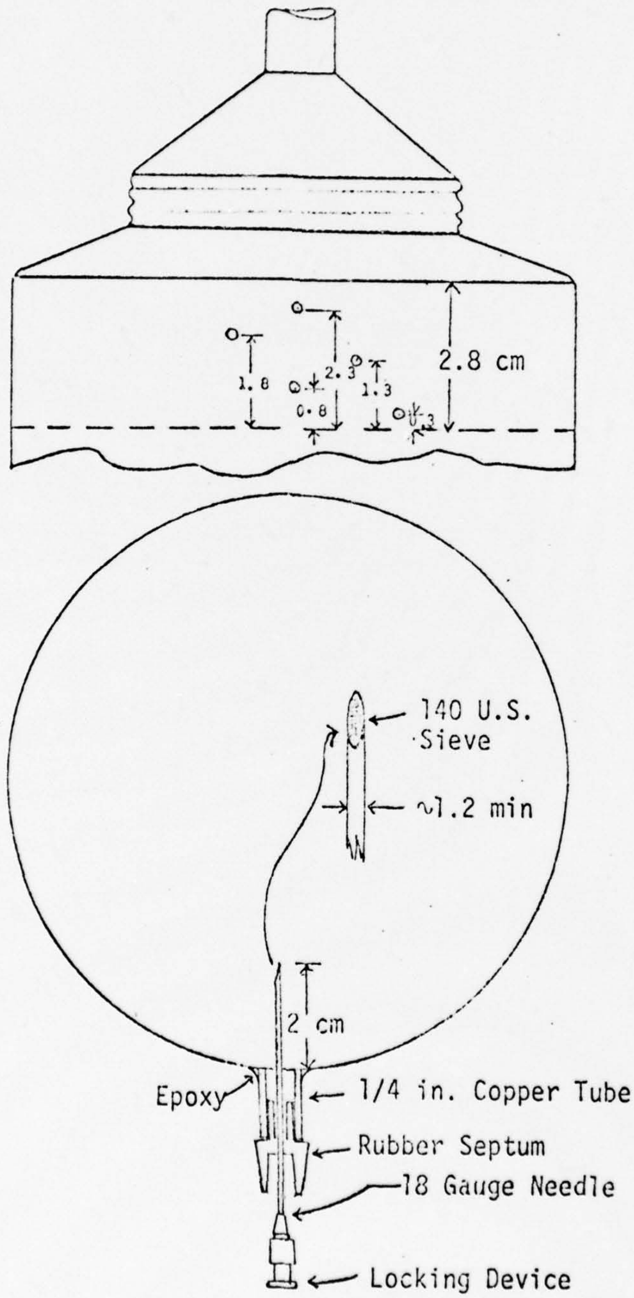

Figure 2 - Location and Design of Probes

The canisters as received had a non-woven fabric attached to the effluent face. This fabric bulged inward, hence, the depth of whetlerite at the center would be less than at the periphery. The non-woven fabric was replaced with a woven fabric which laid flat.

Figure 3 shows (1) a graduated cylinder measuring device by which an exact volume of whetlerite can be measured and (2) a device by which the measured volume can then be loaded into the canister. During the loading, the canister was rotated to further insure evenness of loading. On repeated loadings, the depth of whetlerite did not vary by more than 0.05 cm along the periphery of the canister. At 220 cc the weight was consistently at 131 g and at 230 cc at 137 g, giving a density of 0.595 g/cc for the dry whetlerite.

To insure constant quality of whetlerite over successive tests, a 35 liter blended batch was set aside. After blending, the whetlerite was dried at 150°C for at least 3 hr and then stored in 1-gallon air-tight cans.

Whetlerite used was ASC (MIL-C-0013724B[MU]) 12 to 30 U.S. sieve size range.

Prior to the probe-in-bed testing the whetlerite was equilibrated at 80% RH on equilibration line similar to that shown in figure 2 of First Quarterly Report ED-CR-76087, but used then for SO_2 aging. Moisture adsorption was usually between 29% and 30% by weight. Some were at slightly below 28% and some near 31%, but no significantly different CK life could be traced to these differences in amount of moisture adsorbed.

III. CK VAPOR GENERATION

The CK testing was started with vapor generation made with generator as shown in figure 4. The shell of the constant temperature bath is a plastic container, 5 gal, covered with about 1-1/4 in. of polyurethane foam insulation. The cooling is by means of a stainless steel cylinder containing dry ice. A layer of wet ice forms on the cylinder which maintains the water at 0°C. By adding dry ice to the cylinder at measured intervals, the wet ice layer quantity can be maintained at a level to keep the bath at 0°C. The CK flask is a 2 ℓ Erlenmeyer. About 1 pound or

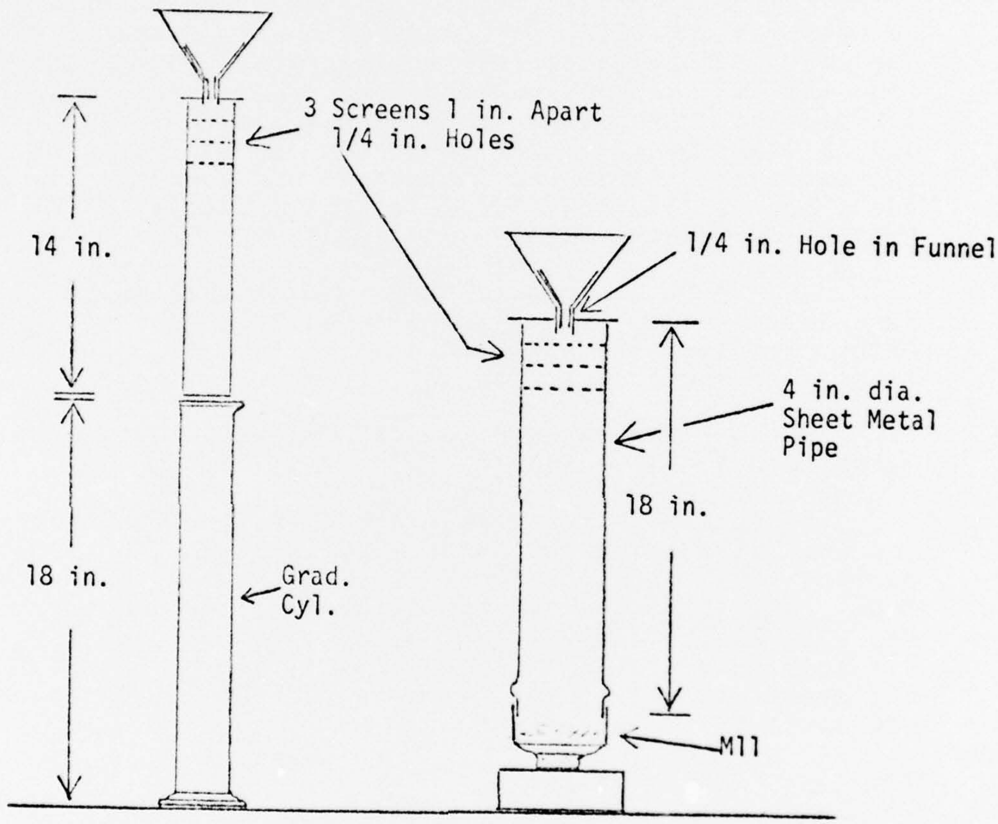

Figure 3 - Devices for Measuring Whetlerite Volume and Loading M11 Test Canister

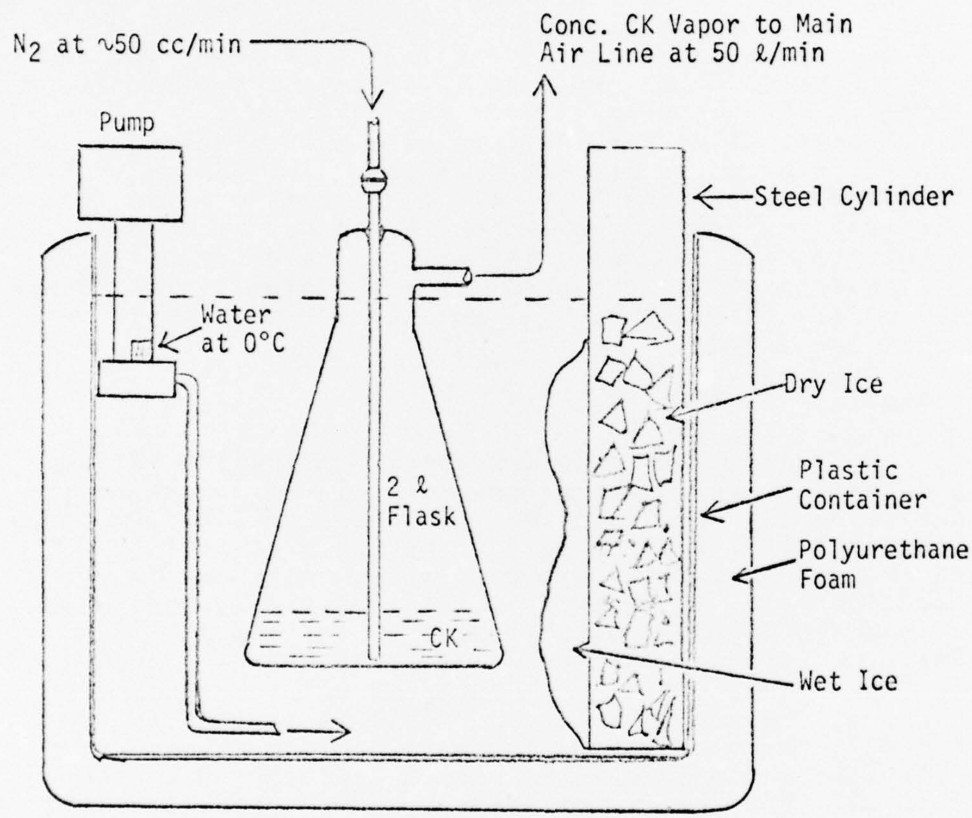

Figure 4 - CK Vapor Generator

about 3/4 in. layer is distilled into the flask at 0°C from a cylinder. CK concentration could be maintained between 3.8 and 4.2 mg/ℓ by this system.

An undesirable characteristic of this system is that it takes several hours to get it cooled down to 0°C. To save time, direct metering of CK from the cylinder was tried for several runs, (runs 19, 20, 21, 24 and 26). For these runs the CK life decreased from what it had been previously, so it was felt that some impurity was in the CK which was removed by distillation from the cylinder to the generator, hence the difference in CK life. Subsequent runs were again made using the generator, but no improvement in CK life occurred. The change in CK life was due to other causes. It is now believed that direct metering from the cylinder is the better method. It eliminates all the delay in cooling the generator and also it was possible to control the CK concentration closer to 4.0 mg/ℓ. This method will be used for the remaining tests of the program.

IV. PHASE 1A CK TESTING

Figures 5 through 9 present graphically various sets of data in which the probes were placed 0.5 cm apart to determine the locations for the probes at 25%, 50% and 75% of total CK life. Table I gives the distances at which the probes should then be placed. Although there was considerable variance in (total) gas lives, the probe locations did not vary significantly. For the 75% location, the average distance was 2.54 cm with a standard deviation of 0.05 cm. For the 50% and 25% locations the standard deviations were larger. This is as good as can be expected since the probe is about 0.12 cm diameter and the whetlerite granules range in diameter from 0.06 to 0.17 cm. The way a whetlerite granule lodges in front of the hole in the probe can significantly affect the penetration time reading. The significant fact from these results is that the probe does not tell how many minutes of gas life has been used up but tells the percentage of the gas life, no matter how short or long.

Table II presents data on tests in which the probes were located in the canister at the 25%, 50% and 75% locations as determined on the basis of sets of runs as given in the figures and table I. As indicated in the table, only a limited number of the runs can be considered successful and most of these were toward the end of the

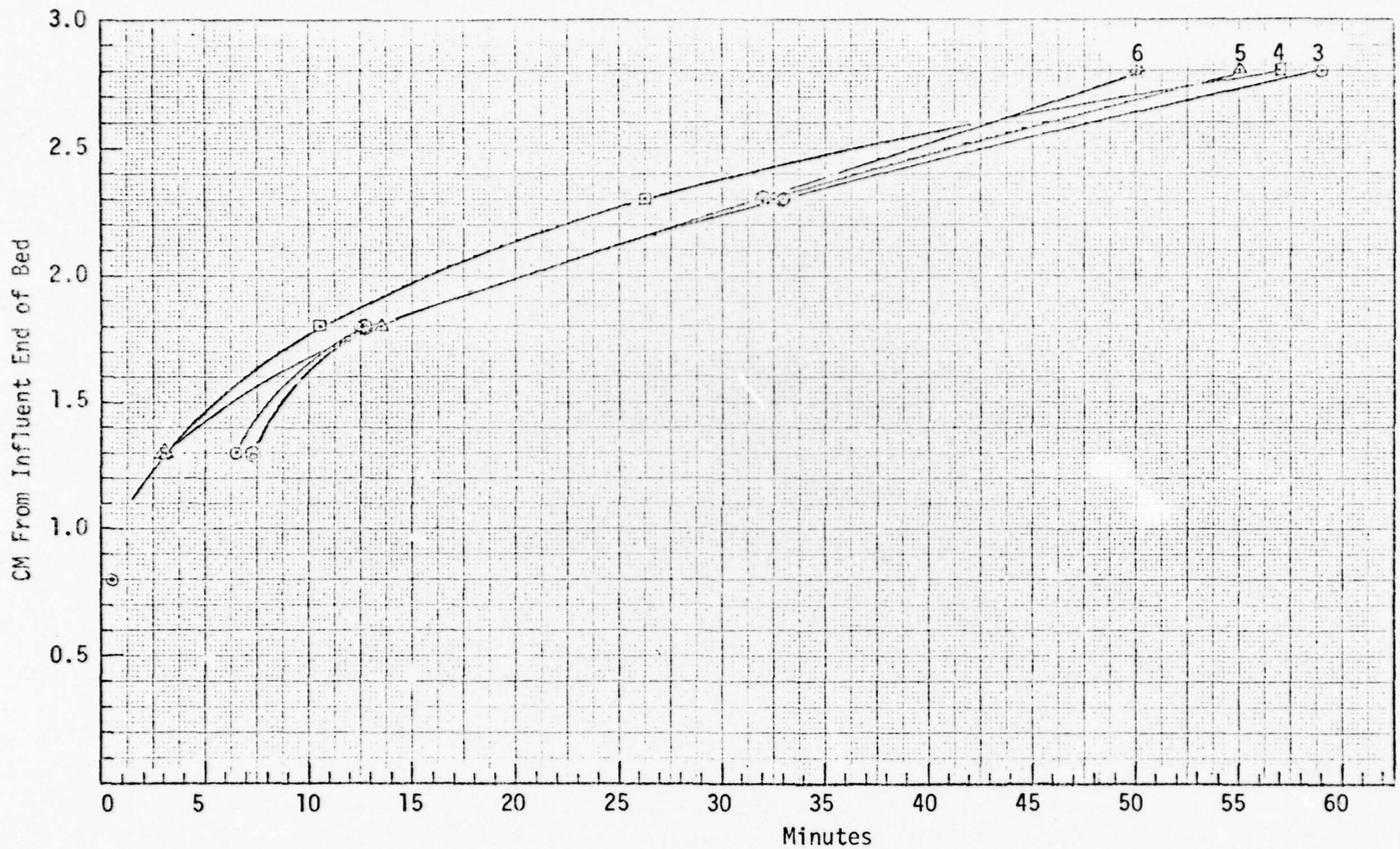

Figure 5 - Gas Lives to Probes in M11 Bed, Runs 3 to 6 inclusive. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min Flow, 80%-80% RH, Front Concentration of 0.016 MG/L.

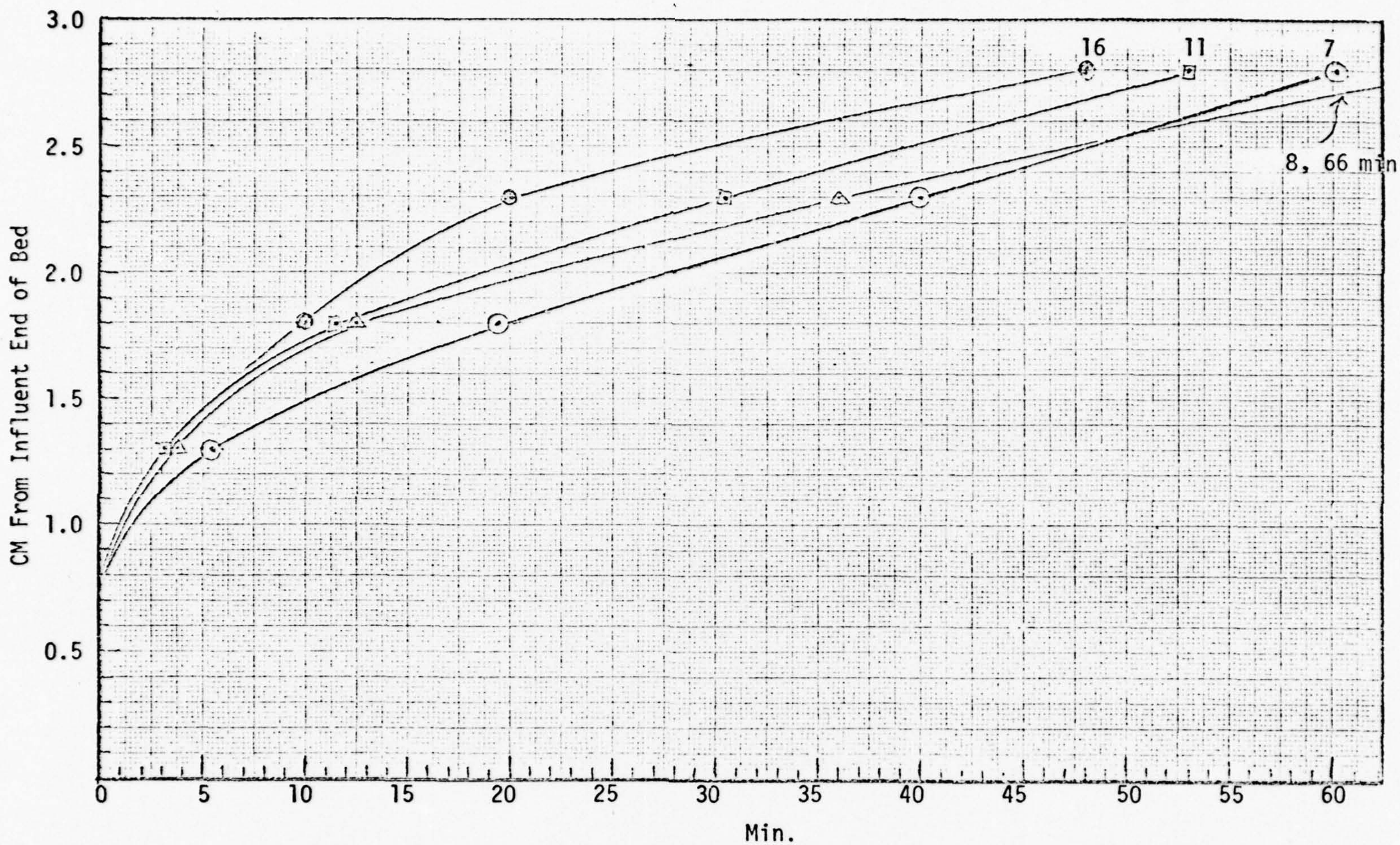

Figure 6 - Gas Lives to Probes in M11 Bed, Runs 7, 8, 11 and 16. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min, 80%-80% RH, Front Concentration 0.016 MG/L on Runs 7 and 8, Others 0.008 MG/L.

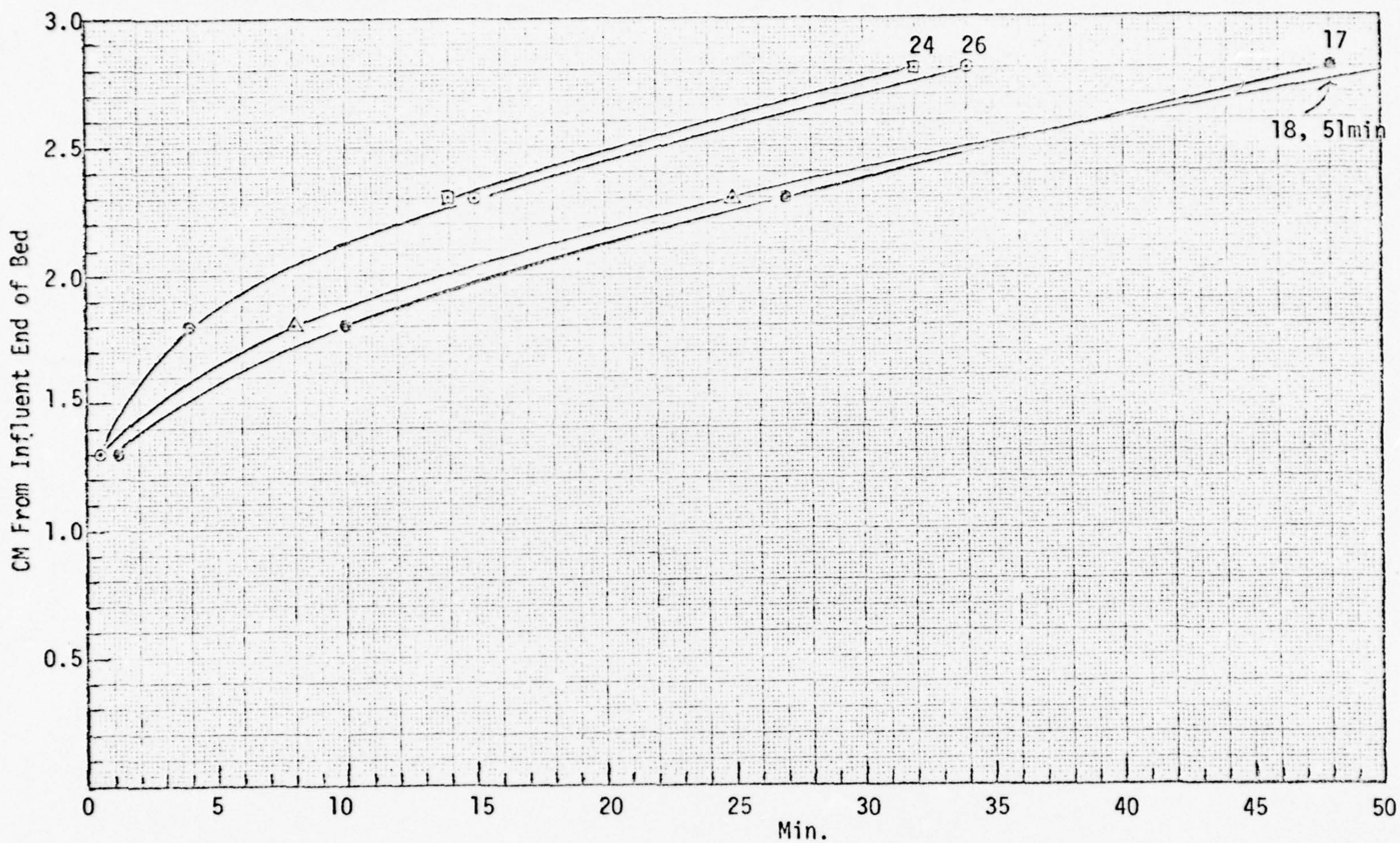

Figure 7 - Gas Lives to Probes in M11 Bed, Runs 17, 18, 24 and 26. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min Flow, 80%-80% RH, Front Concentration 0.008 MG/L.

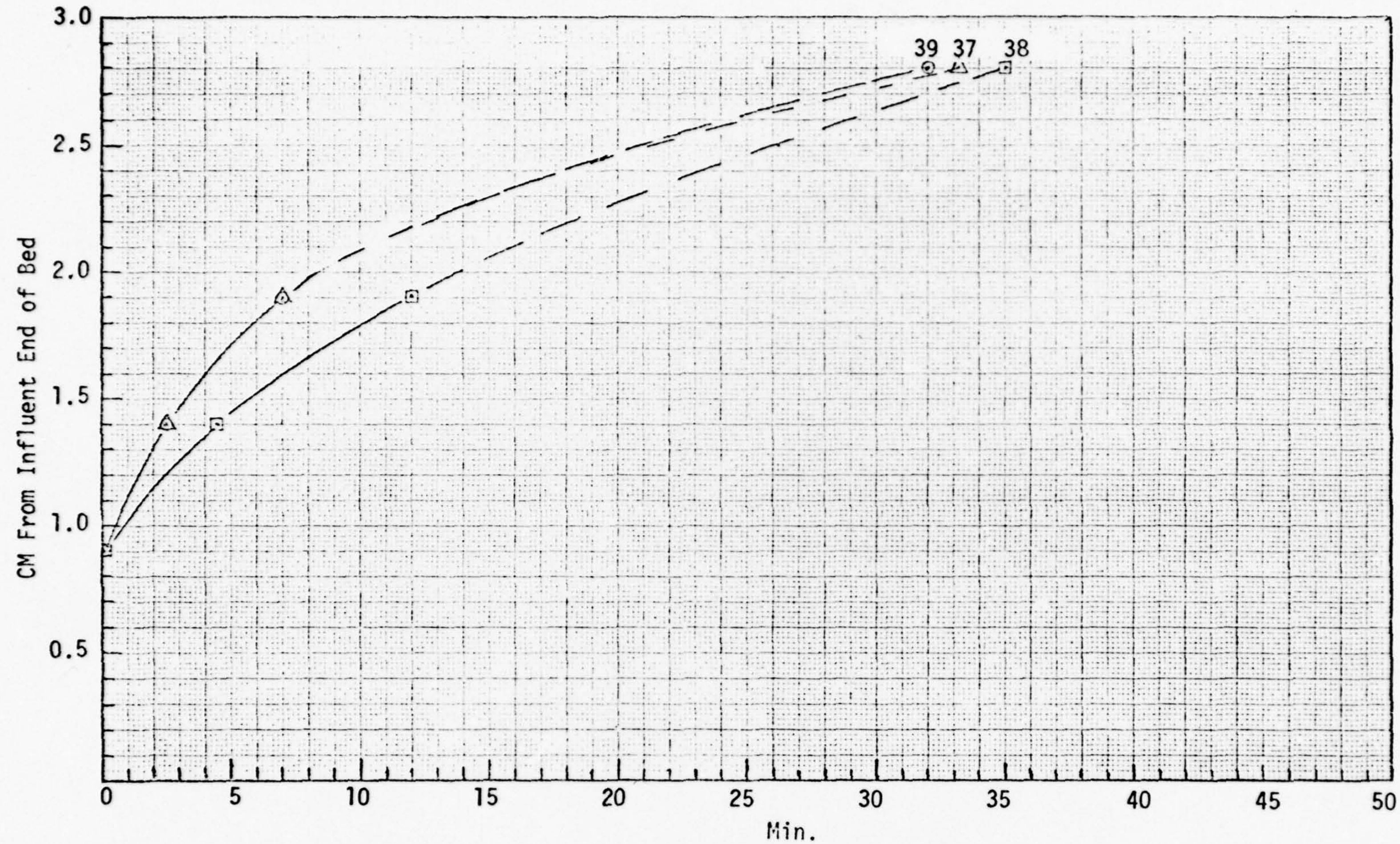

Figure 8 - Gas Lives to Probes in M11 Bed, Runs 37, 38 and 39. Whetlerite 137 GM, 4.0 MG/L CK, 50 L/Min, 80%-80% RH, Front Concentration 0.008 MG/L.

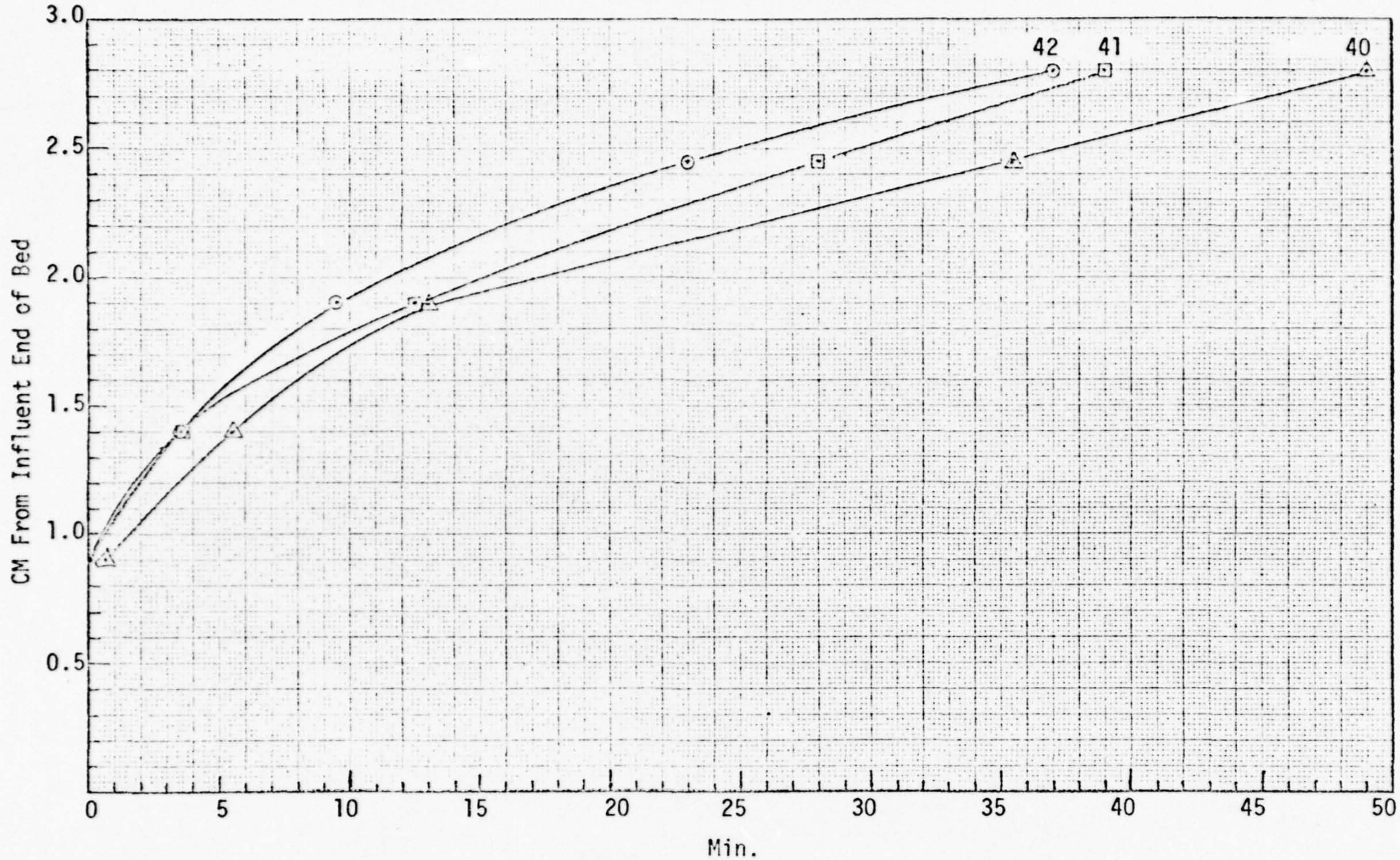

Figure 9 - Gas Lives to Probes in M11 Bed, Runs 40, 41 and 42. Whetlerite 137 GM, 4.0 MG/L CK, 50 L/Min, 80%-80% RH, Front Concentration 0.008 MG/L.

TABLE I - LOCATIONS OF PROBES AT 25%, 50%, AND 75% OF GAS LIFE AS DETERMINED FROM FIGURES 5, 6, 7, 8 & 9.

Run No.	Life, Min	75%		50%		25%	
		Min	CM	Min	CM	Min	CM
3	59	44	2.52	29.5	2.23	15	1.85
4	57	43	2.54	28.5	2.36	14.5	1.86
5	55	41	2.58	27.5	2.21	14	1.82
6	50	37.5	2.46	25.0	2.12	12.5	1.80
7	60	45	2.42	30	2.04	15	1.66
8	66	49	2.52	33	2.24	16.5	1.89
11	53	40	2.52	26.5	2.20	13	1.84
16	48	36	2.60	24	2.38	12	1.92
17	48	36	2.52	24	2.22	12	1.87
18	51	38	2.57	25.5	2.32	12.5	1.96
24(2)	32	24	2.59	16	2.38	8	2.03
26(1)	34	25.5	2.59	17	2.36	8.5	2.06
37	33	24.8	2.60	16.5	2.36	8.2	1.98
38	35	26.2	2.50	17.5	2.18	8.8	1.71
39	32	24	2.59	16	2.26	8.0	1.97
40	49	37	2.49	24.8	2.19	12.4	1.88
41	39	29.3	2.52	19.5	2.16	9.8	1.78
42	37	27.7	2.58	18.5	2.30	9.2	1.88
Averages			2.54		2.25		1.88
Std. Dev.			0.05		0.095		0.10

(1) Runs up to and including 26, 131 gm whetlerite per M11 canister, others 137 gm.

(2) Runs 24 and 26, CK metered directly from cylinder, others from generator at zero degrees centigrade.

Note: For these tests CK was 4.0 MG/L, 50 L/MIN, and 80%-80% RH, Runs 3 thru 8 front conc. 0.016 MG/L, all others 0.008 MG/L.

TABLE II - TEST RUNS ON M11 WITH PROBES LOCATED TO GIVE GAS LIVES OF 25%, 50%, AND 75% OF TOTAL GAS LIFE.

Run No.	Life, Min	75% Intended			50% Intended			25% Intended		
		CM	Min	%	CM	Min	%	CM	Min	%
10	56	2.5	37	66	2.2	25	45	1.9	6.8	12
12	43	2.5	43	100	2.2	28	65	1.9	13.5	31
13	48	2.5	21	44	2.2	16	33	1.9	5.5	10
14 (1)	51	2.5	35	69	2.2	27	53	1.9	11	22
15	47	2.5	32.5	69	2.2	22.5	48	1.9	3.8	8
19 (2)	58	2.6	57	98	2.3	45	78	1.9	25.5	44
20 (2)	41	2.6	40	98	2.3	31	75	1.9	19.5	47
21 (2)	42	2.6	41	98	2.3	31.5	75	1.9	18	43
43 (3)	48.5	2.55	40.5	83	2.25	27	56	1.9	10.5	22
44	51	2.55	51	100	2.25	39	76	1.9	15	29
45 (1)	40	2.55	32.5	81	2.25	23	56	1.9	7	17
46	39.5	2.45	33	83	2.2	24	61	1.95	12.5	32
47 (1)	37	2.4	28	75	2.15	20.5	51	1.9	8	22
48	32.5	2.4	22.5	70	2.15	15	46	1.9	7	22
49	37	2.4	37	100	2.15	26	70	1.9	10	27
50 (1)	43	2.45	35	81	2.2	22	51	1.85	11	26
51 (1)	42	2.4	32	76	2.2	22	52	1.85	9	21

(1) Satisfactory Runs

(2) CK metered directly from cylinder, others from generator at zero degrees

(3) Runs up to and including 21, 131 GM whetlerite per M11 canister, others 137 GM

Note: For these tests, CK was 4.0 MG/L, 50 L/MIN, and 80%-80% RH, adsorption front concentration 0.008 MG/L

study after all the refinements in the method, discussed earlier, had been made. Another conclusion that can be drawn is that the method, at least for CK, is subject to considerable error. A probe located at the 75% level, and when all other conditions are favorable, might indicate the consumed gas life with an error of ±6%, i.e. between 69% and 81%.

In phase III, tests were to be conducted in which the probe would be placed to indicate a residual CK gas life of 5 minutes. As the results already performed have indicated, the probe would be located at about 0.1 cm from the bed effluent end. At this distance the accuracy would be very poor.

A possible way to circumvent this problem was to measure the adsorption front for the 5-min probe at a higher concentration than 0.008 mg/ℓ but located further from the effluent end. Total gas life would still be determined at 0.008 mg/ℓ effluent concentration. To determine where the probe should be placed, runs were again made with probes located 0.5 cm apart but the time to each probe measured at three concentrations, 0.008, 0.016 and 0.043 mg/ℓ. The results of these test runs are given graphically in figures 10 through 15. Table III gives the probe locations when the adsorption front concentration was 0.043 mg/ℓ. Several runs were made with the probe at 2.41 cm but none of the runs were successful.

The problem of determining the 5-min residual gas life was discussed with the project monitor and the decision was made that the gas life at the 75% location would be used in phase III. Table IV gives the probe locations determined for 75%, 50% and 25% of gas life measured at 0.008 mg/ℓ effluent concentration.

Figures 5 through 15 give additional information, i.e. the critical bed depth. By drawing a straight line through the points for the 2.3 and 2.8 cm probes and extrapolating the line to the ordinate, the critical bed depths as given in table V were determined. The critical bed depths are of the order of 60% of the total bed depth. Generally, the adsorption front, after steady state has been reached and when measured at low effluent concentration, is twice the critical bed depth. The fact that the critical bed depth

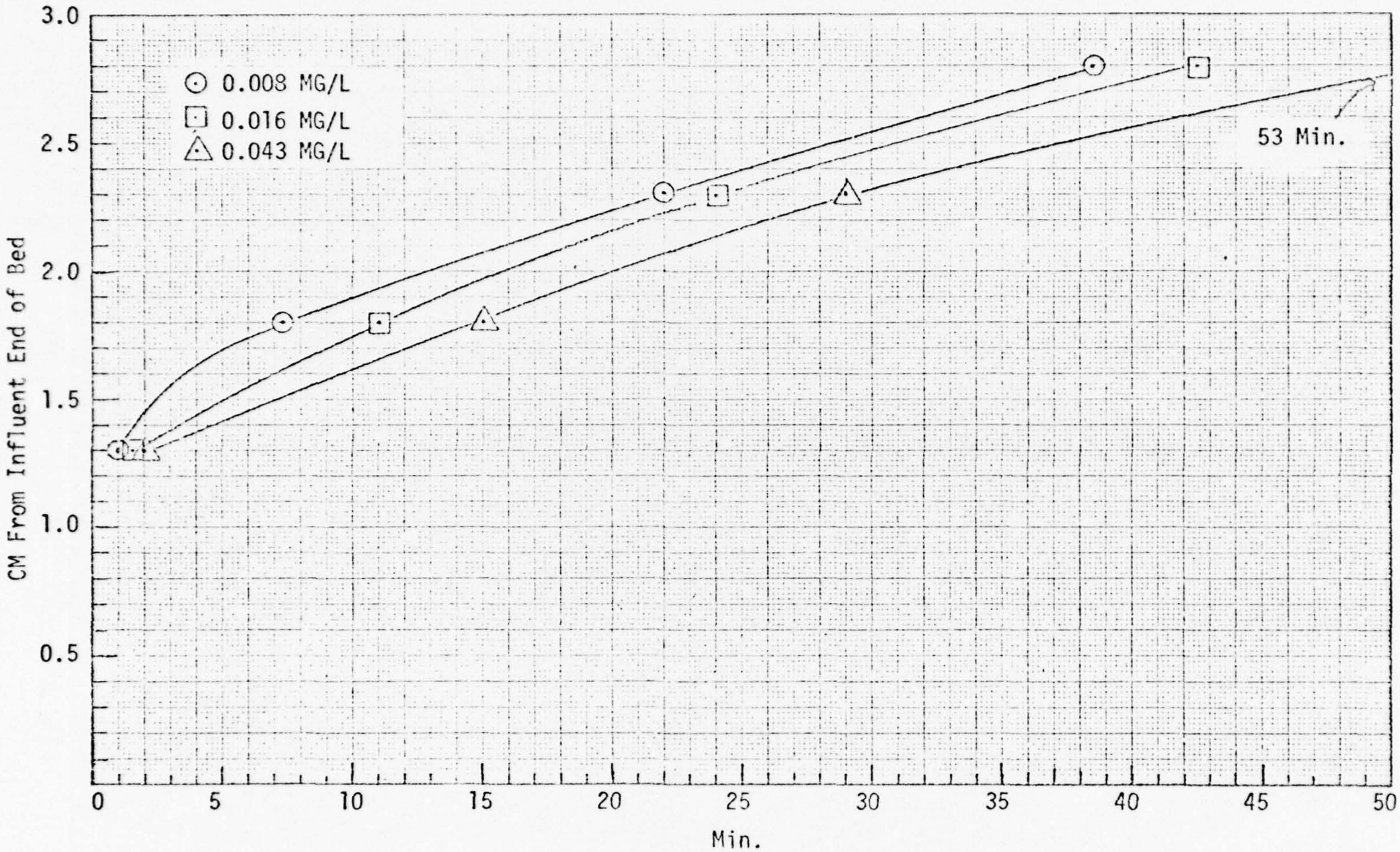

Figure 10 - Gas Lives to Probes in M11 Bed at Different Adsorption Front Concentrations, Run 25. Whet. 131 GM, 4.0 MG/L CK, 50 L/Min, 80%-80% RH.

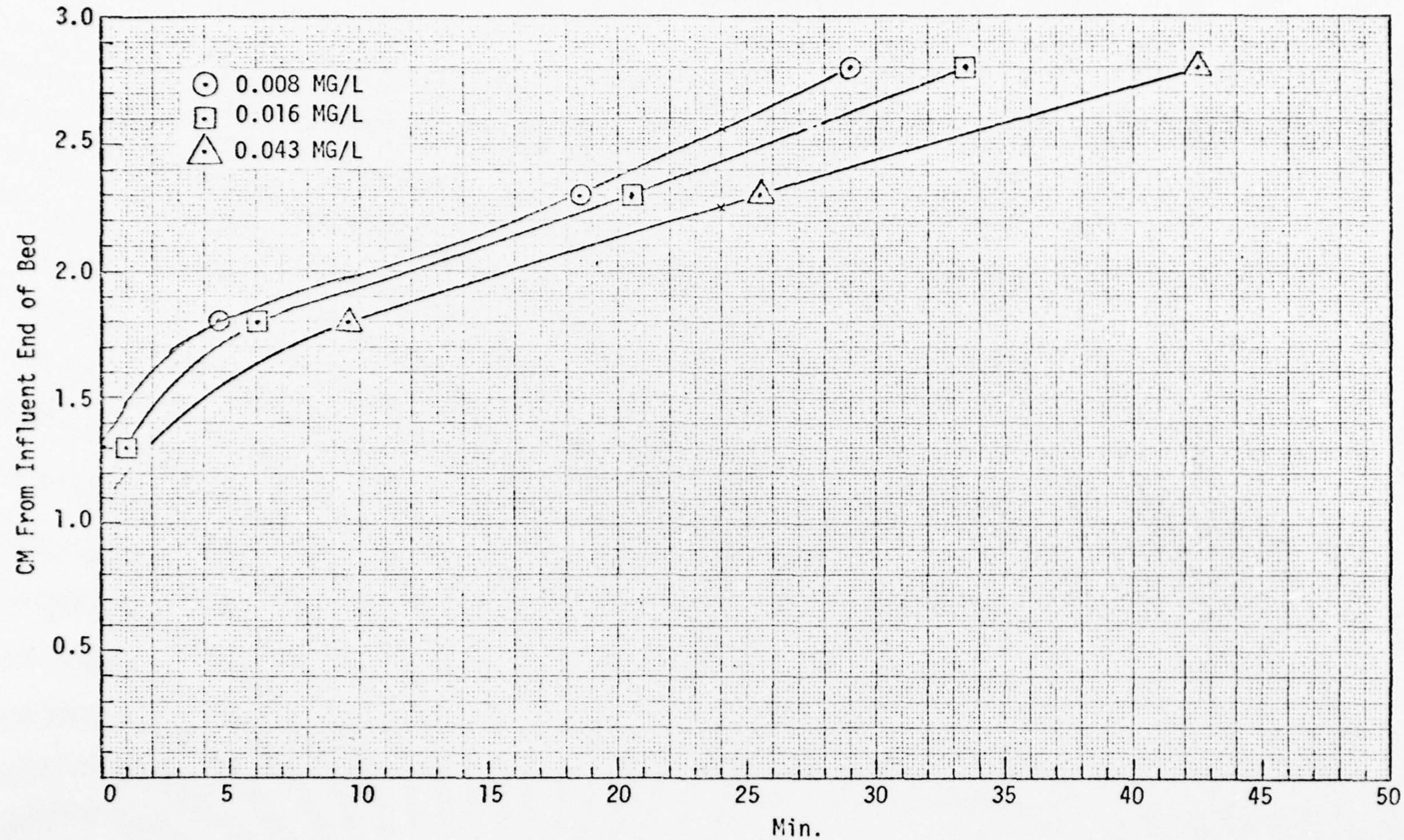

Figure 11 - Gas Lives to Probes in M11 Bed at Different Adsorption Front Concentrations, Run 28. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min Flow, 80%-80% RH.

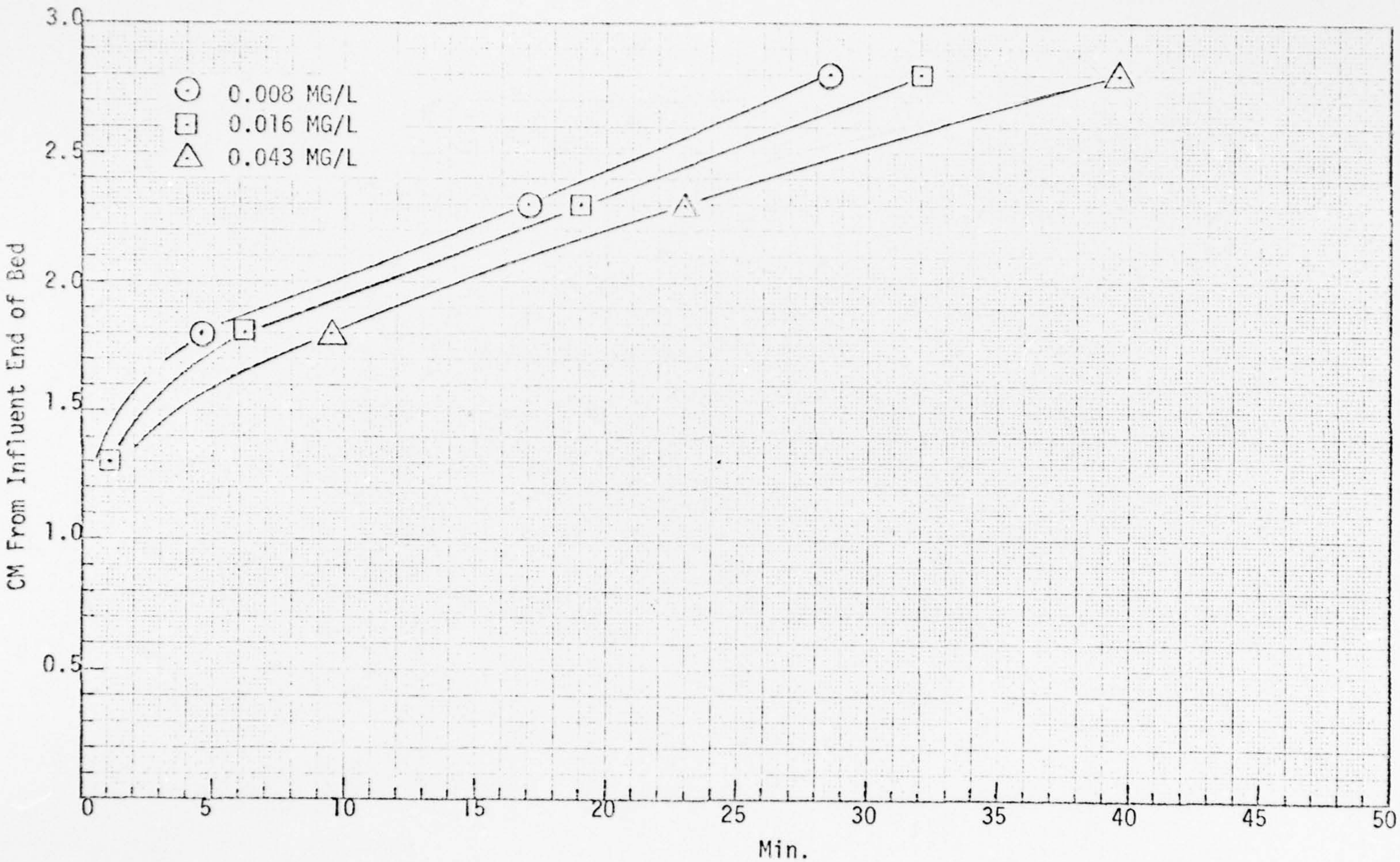

Figure 12 - Gas Lives to Probes in M11 Bed at Different Adsorption Front Concentrations, Run 29. Whet. 131 GM, 4.0 MG/L CK, 50 L/Min 80%-80% RH

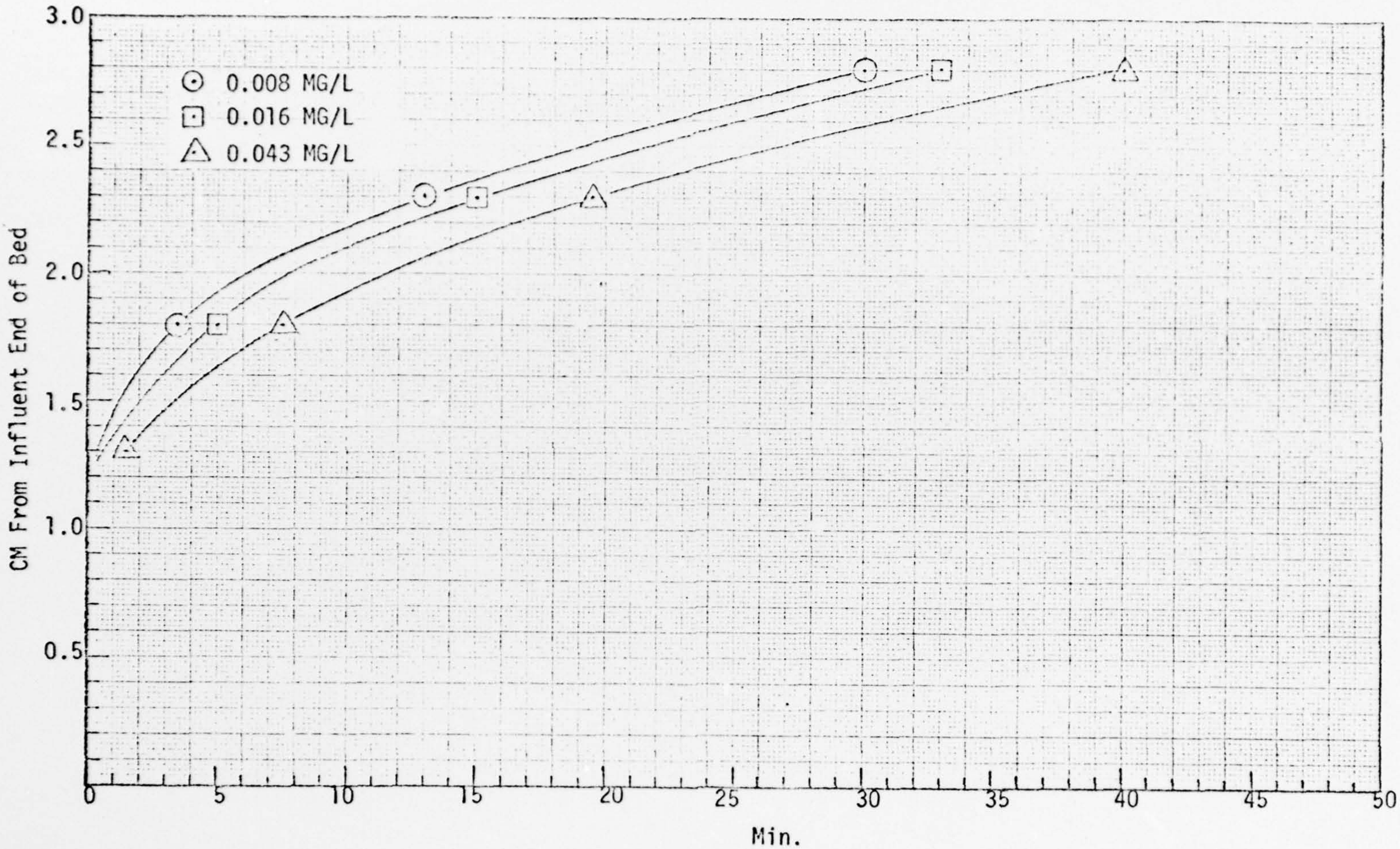

Figure 13 - Gas Lives to Probes in M11 Bed at Different Adsorption Front Concentrations, Run 30. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min, 80%-80% RH.

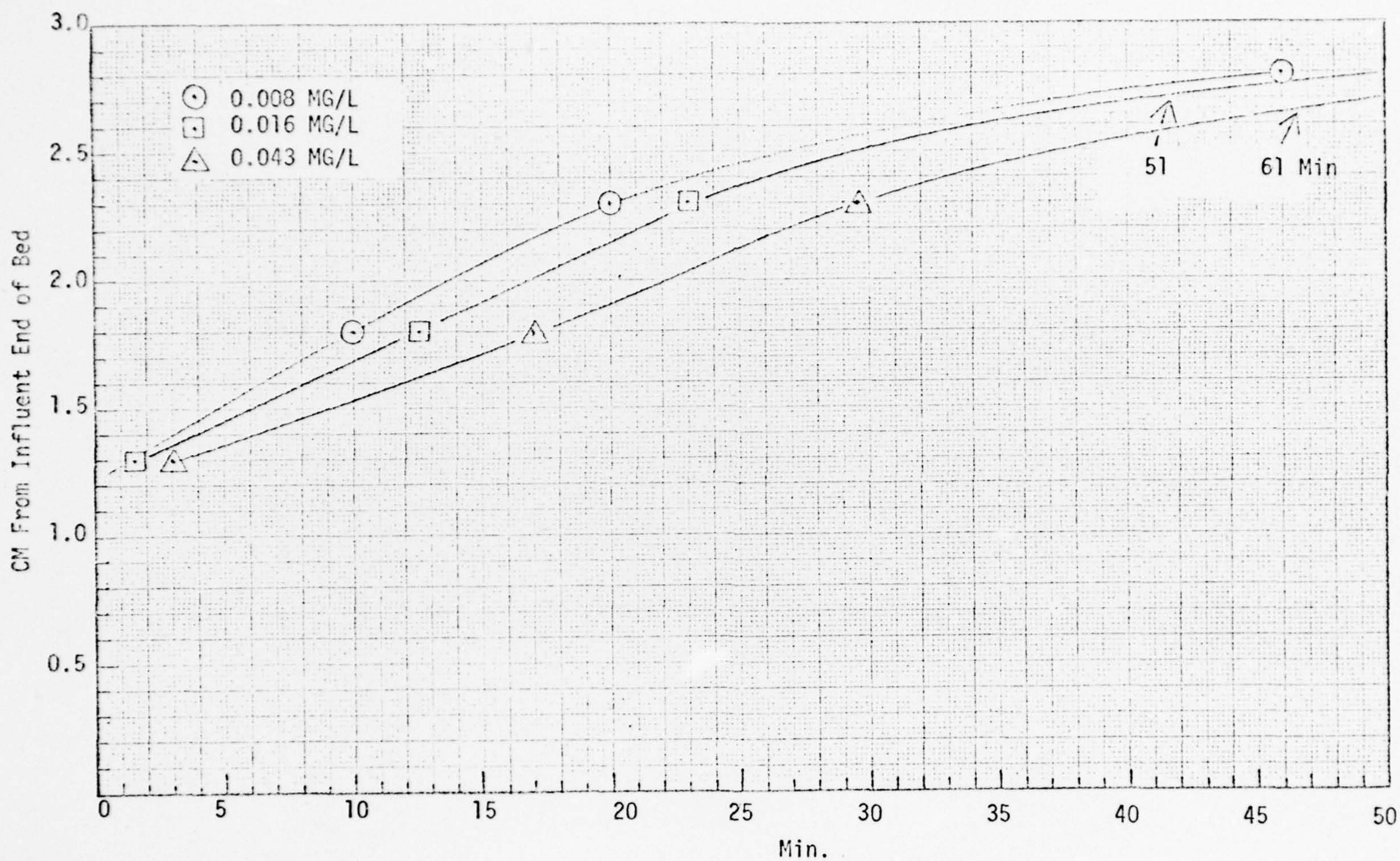

Figure 14 - Gas Lives to Probes in M11 Bed at Different Adsorption Front Concentrations, Run 31. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min Flow, 80%-80% RH.

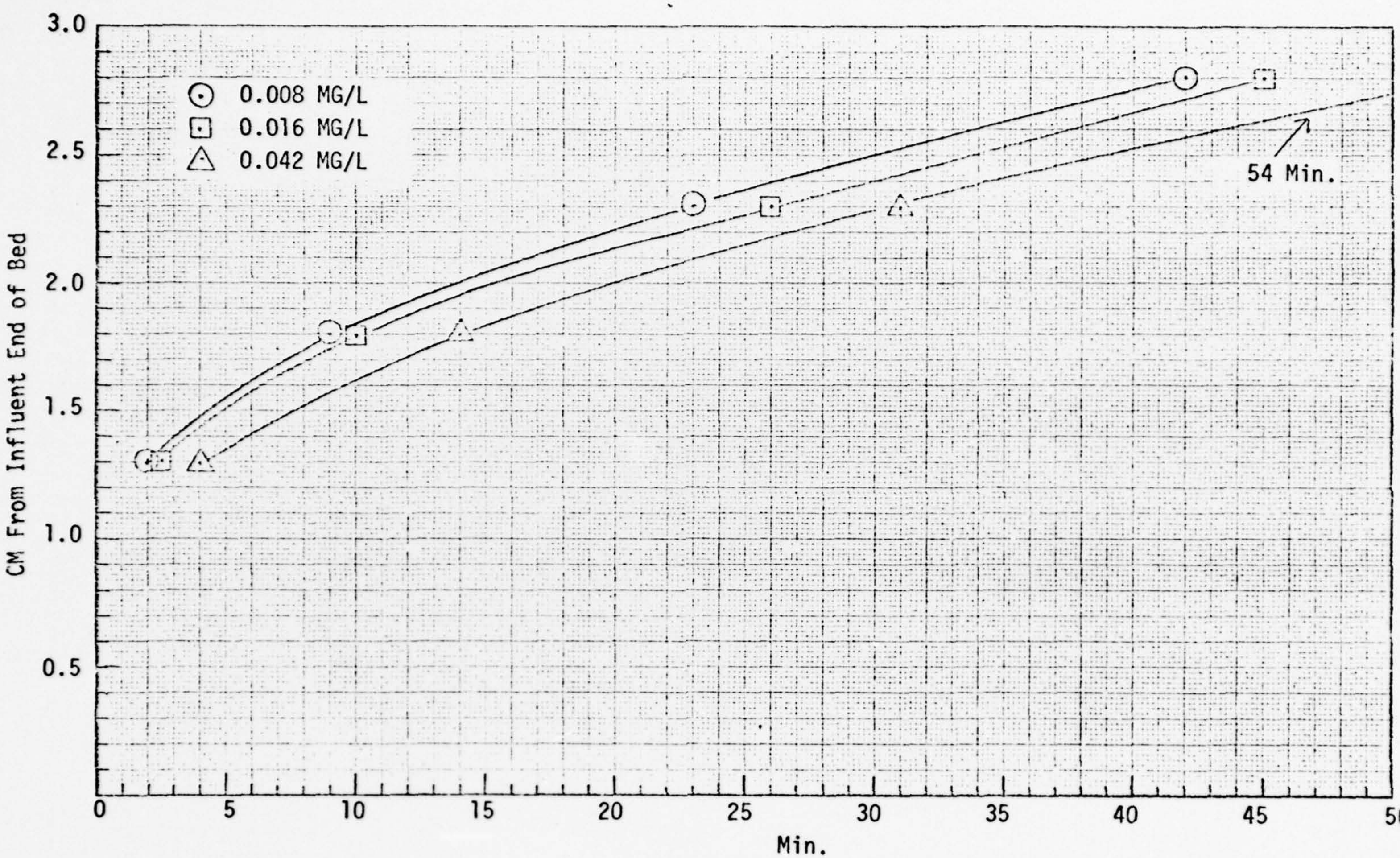

Figure 15 - Gas Lives to Probes in M11 Bed at Different Adsorption Front Concentrations, Run 32. Whetlerite 131 GM, 4.0 MG/L CK, 50 L/Min Flow, 80%-80% RH

TABLE III - LOCATION OF PROBE TO GIVE 5 MIN RESIDUAL GAS LIFE.*

Run No.	Gas Life at 0.008 MG/L	Location of Probe, cm from Influent End of Bed	
25	38.5		2.41
28	29		2.25
29	28.5		2.32
30	30		2.48
31	46		2.56
32	42		2.46
		Average	2.41
		Std. Dev.	0.11

*When bed effluent concentration is 0.008 MG/L and adsorption front concentration at probe is 0.043 MG/L. Data from Figures 10 to 15.

TABLE IV - LOCATIONS OF PROBES AT 25%, 50% and 75% OF GAS LIVES.*

Run No.	Gas Life at 0.008 MG/L, min	75% Intended Min	75% Intended CM	50% Intended Min	50% Intended CM	25% Intended Min	25% Intended CM
		Time, Loc. Probe When Front Conc 0.008 MG/L					
25	38.5	29	2.52	19	2.20	9.6	1.88
28	29	21.5	2.44	14.5	2.14	7.2	1.90
29	28.5	31.5	2.49	14	2.18	7.1	1.90
30	30	22.5	2.60	15	2.37	7.5	2.07
31	46	34.5	2.65	23	2.39	11.5	1.88
32	42	31.5	2.56	21	2.26	10.5	1.86
	Averages		2.54		2.26		1.91
	Std Dev.		0.08		0.10		0.08
		Loc. Probe When Front Conc 0.016 MG/L					
25			2.44		2.12		1.72
28			2.34		2.09		1.85
29			2.39		2.10		1.83
30			2.53		2.30		1.98
31			2.60		2.30		1.76
32			2.44		2.16		1.81
	Averages		2.45		2.18		1.82
	Std Dev.		0.09		0.10		0.09
		Loc. Probe When Front Conc 0.043 MG/L					
25			2.30		1.96		1.60
28			2.18		1.96		1.69
29			2.25		1.98		1.69
30			2.39		2.14		1.80
31			2.44		2.03		1.58
32			2.33		2.03		1.64
	Averages		2.32		2.02		1.67
	Std Dev.		0.09		0.07		0.08

*As determined from Figures 10 through 15 at three different adsorption front concentrations, 131 GM whet per M11, 4.0 MG/L CK, 50 L/Min flow, 80%-80% RH.

TABLE V - CRITICAL BED DEPTHS OF CK RUNS IN M11 CANISTER.*

Run No.	Critical Bed Depth at Different Adsorption Front Concnetrations, CM		
	0.008 MG/L	0.016 MG/L	0.043 MG/L
3		1.7	
4		1.9	
5		1.6	
6		1.3	
7		1.3	
8		1.7	
11	1.6		
16	1.9		
17	1.6		
18	1.8		
24	1.9		
26	1.9		
40	1.6		
41	1.6		
42	1.9		
25	1.6	1.6	1.6
28	---	1.6	1.5
29	1.5	1.6	1.6
30	1.9	1.9	1.8
31	1.9	1.9	1.8
32	1.7	1.6	1.6
Averages	1.7	1.6	1.6

*Conditions: 4.0 MG/L CK conc, 50 L/Min, 80%-80% RH.

is 60% of the total bed depth indicates that the adsorption front has not attained steady state and extends the total length of the bed.

Why this is so is due to the fact that the critical bed depth has no reality in the adsorption process but is a correction factor in the Mecklenburg equation which follows.

$$t = \frac{NAd}{FC_i} [L - X] \qquad (1)$$

Here X is the critical bed depth while t is the gas life, N is the saturation capacity of the carbon at influent concentration C_i, A is the bed area, F the flow rate, and L the bed depth. By plotting experimentally determined t against different L, a life thickness curve as shown in figure 16 is obtained. By extrapolating the straight portion of the curve to the abscissa, a numerical value for X is obtained. X varies with C_b, the breakpoint concentration, becoming zero when $C_b = 0.5\ C_i$ or negative when $C_b > 0.5\ C_i$.

The adsorption front length is the distance to B and depends on how low a concentration the leading edge is measured. Theoretically the front length is infinitely long at zero leading edge concentration. It is always at least two times longer than X if C_b is used to determine X and also front length.

Figure 17 shows the front profile in the carbon bed. The Mecklenburg equation treats the front as a square front with zero length. When C_b is small relative to C_i, the shaded areas shown in the figure are about equal on each side of the square front. In this case the adsorption front is double X. Since X for the CK test results is about 60% of the total bed depth, it can only mean that the adsorption front is still developing, i.e. it had not reached a steady state. There is also no saturated layer in the whetlerite bed.

V. PHASE 1B CK TESTING

In these studies, the probes were placed at the 25%, 50% and 75% of total-gas-life locations in the whetlerite bed. CK-air mixture under the test conditions was metered through the canister until the 25% probe showed 0.008 mg/ℓ CK concentration. The CK input was stopped and pure air metered through the canister for 45 min. CK-air mixture was then again metered through the canister until the 50%-probe showed 0.008 mg/ℓ CK concentration. CK input was again stopped for 45 min. The above procedure was

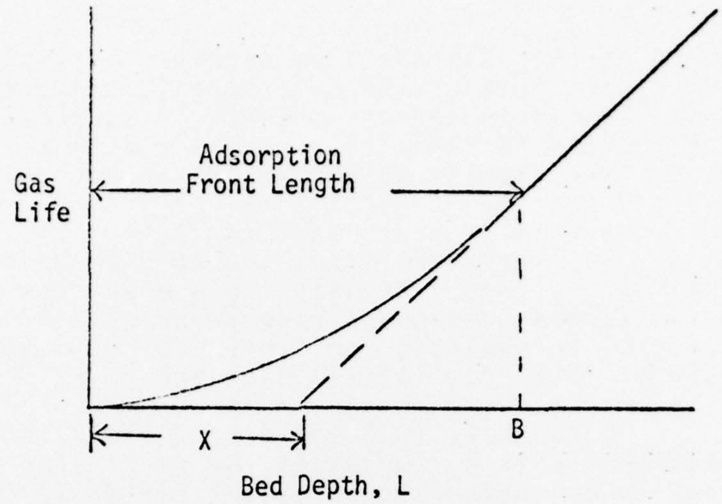

Figure 16 - Life-Thickness Curve

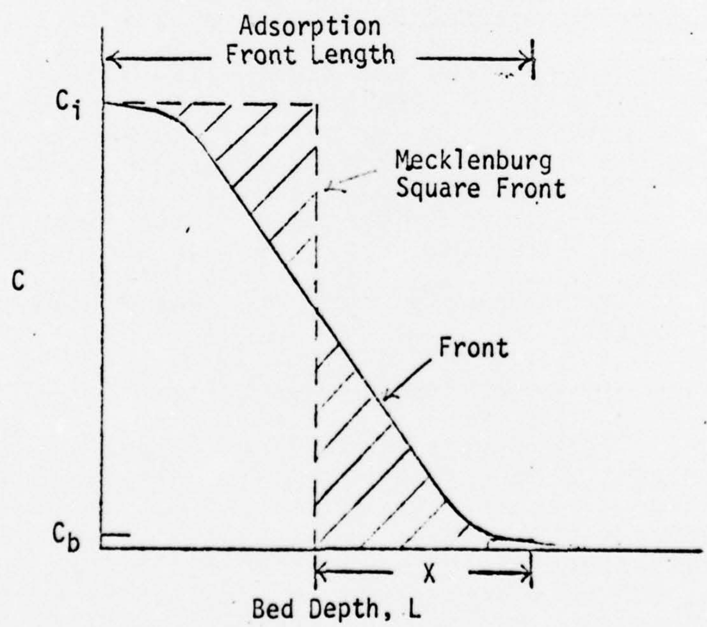

Figure 17 - Adsorption Front Profile in Carbon Bed

repeated for the 75% and 100% probes. The main objective of the experiments was to determine if measurable quantities of CK drifted through the bed to the next probe during the period in which only pure air was passed through the bed. The results showed no measurable downstream drift of CK.

Two runs were made, the results given in tables VI and VII. Column 4 of each table gives the cumulative time to CK breakthrough at each probe when CK-air mixture was metered through the canister. Column 5 gives the percentage of total gas life at each probe.

Columns 6, 7, 8 and 9 of table VI show the concentration recovery time after the CK is added to the airstream. Under number 1, it took 3.5 min for CK concentration at the 25% probe to rise to 0.008 mg/ℓ after the 45 min pure air flow period and CK readmitted to the air stream. On the second cycle, under number 2, the 25% probe regained in 1.5 min and on the third and fourth cycles it regained immediately. In the same manner, the 50% probe regained in 3.0 min on its first cycle, and 2 min on its second cycle and immediately on its third cycle. The 75% probe regained in 3.0 min on its first cycle.

The last two columns in table VII give the length of time the concentration at each probe decreases to zero after the pure air flow is started and the recovery of the CK concentration to 0.008 mg/ℓ after the CK input is started again. These results show that the CK life is increased from 40 to 44.75 min by the interrupted flow and also that the test gas, i.e. if CK is used, would have to be metered into the whetlerite bed for several minutes to be assured of a definite indication regarding the residual gas life of the filter.

VI. PHASE II CK TESTING

Table VIII presents the CK test results on whetlerites that were aged or exposed to low concentrations of vapors for 17 weeks. Over this period of time 600 g of whetlerite that had been equilibrated at 80% RH was placed in a sealed bottle and held at 90°F. For each of the three vapors, 600 g of whetlerite was exposed to an airstream at 5 ℓ/min, 80% RH, and containing 7 ppm xylene or formaldehyde vapor or 15 ppm sulfur dioxide. For each CK test run, 230 cc of the aged or treated whetlerite was loaded into the M11 test canister. In each case there was a drastic decrease in CK life. The probes were also considerably off in predicting the correct percentage of gas life.

TABLE VI - INTERRUPTED RUN, CK FEED AND PURE AIR, RUN 53.*

Probe No.	CM	Intended %	Time, Min	%	Recovery to 0.008 MG/L, Min			
					1	2	3	4
1	1.9	25	10	23.5	3.5	1.5	0	0
2	2.15	50	21.5	50		3.0	2	0
3	2.4	75	33.5	78			3	0
4	2.8	100	42.7	100				

*45 Min pure airflow after 0.008 MG/L conc. breakthrough at each probe, 137 GM whet. in M11 bed, 4.0 MG/L CK, 50 L/Min flow, 80%-80% RH.

TABLE VII - INTERRUPTED RUN, CK FEED AND PURE AIR, RUN 61.*

Probe No.	CM	Intended %	Time Min	%	Decrease to Zero Conc., Min	Recovery to 0.008 MG/L, Min
1	1.85	25	11	27	2	2.75
2	2.2	50	25.5	64	2	3.75
3	2.4	75	32.5	81	3	3
4	2.8	100	40	100	3.5	4.75

*45 Min pure airflow after 0.008 MG/L conc. breakthrough at each probe, 137 GM whetlerite in M11 bed, 4.0 MG/L CK, 50 L/Min flow, 80%-80% RH.

TABLE VIII - TEST RUNS ON WHETLERITES AGED AND EXPOSED TO ORGANIC VAPORS.*

Run No.	Treat	Life, Min	75% Intended			50% Intended			25% Intended		
			CM	Min	%	CM	Min	%	CM	Min	%
54	XYL	3	2.4	2.5	83	2.15	2	67	1.9	1	33
55	H_2CO	6.5	2.4	3.2	49	2.15	2.5	39	1.9	1.5	23
56	AGE	7.5	2.4	3.5	47	2.2	3	40	1.85	2	27
57	AGE	6.2	2.4	4	65	2.2	3	48	1.85	2.2	35
58	SO_2	<2	2.4	1.5	>75	2.2	0	0	1.85	0	0

*Aged at 90%° or exposed to airflow with low concentrations of sulfir dioxide, formaldehyde, or xylene; CK at 4.0 MG/L, 50 L/Min flow, 80%-80% RH, Ads. front conc. at 0.008 MG/L, 137 GM whetlerite per M11 canister.

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